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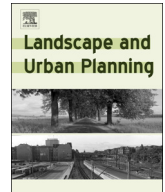
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Rethinking tourism conflict potential within and between groups using participatory mapping

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ABSTRACT

Tourism on small tropical islands in the Global South is a balancing act between development to improve local livelihoods and the conservation of fragile coastal and coral ecosystems. The objective of our study is to develop a series of new spatial metrics to support sustainable development through assessing the direction and magnitude of tourism development support and conflict between groups. We surveyed 317 individuals out of an estimated total population of 3300 using public participation GIS (PPGIS) on Tioman Island, Malaysia. Here we present a first example of how nuances in conflict can be articulated spatially across different levels of attitude toward tourism development within and between different segments of the population. Our results suggest that treating a population as homogeneous risks missing place specific development conflicts between segments of the population and locations of agreement where development can be managed sustainably with the support of the community.

1. Introduction

Global tourism is a trillion-dollar industry, contributing to 10.4% of global GDP and 319 million jobs, or 10% of total global employment in 2018 (World Travel & Tourism Council, 2019). In Southeast Asia coral reefs and small islands are major coastal and marine tourism destinations, offering niche activities such as scuba diving and snorkelling, drawing tourists through the association with exoticism and natural beauty (Jobbins, 2006). Developing tourism in a way that does not harm natural ecosystems is possible given appropriate strategies (Chung, Dietz, & Liu, 2018), however, development often comes at a cost to the natural environment (Andereck, Valentine, Knopf, & Vogt, 2005; Azam, Mahmudul Alam, & Haroon Hafeez, 2018; Craig-Smith, Tapper, & Font, 2006; Hall, 2010). Managing trade-offs between tourism development and the environment are particularly salient in Southeast Asia, which is a global biodiversity hotspot, undergoing rapid

economic development and highly vulnerable to human disturbance and climate change (Coleman et al., 2019; Hughes et al., 2017; Lechner et al., 2019; Sodhi, Koh, Brook, & Ng, 2004).

Previous work has documented the importance of integrating economic and environmental targets, using tourism to support alternative livelihood projects that reduce impacts on coral reefs and other marine resources (Darling et al., 2019; Kurniawan, Adrianto, Geo, & Budi, 2019; Lowe, Tejada, & Meekan, 2019; Runtung et al., 2015). However, the question of how to deal with competing tourism development and environmental preferences in the Global South is a pressing sustainability challenge that is less well understood (e.g. Azam, Mahmudul Alam, & Haroon Hafeez, 2018; Aziz, Clements, Giam, Forget, & Campos-Arceiz, 2017; Darling et al., 2019; Spalding, Burke, Wood, Ashpole, & James, 2017). Sustainable tourism development in these regions depends on the application of novel methods for assessing the potential for development conflicts, and developing novel strategies for

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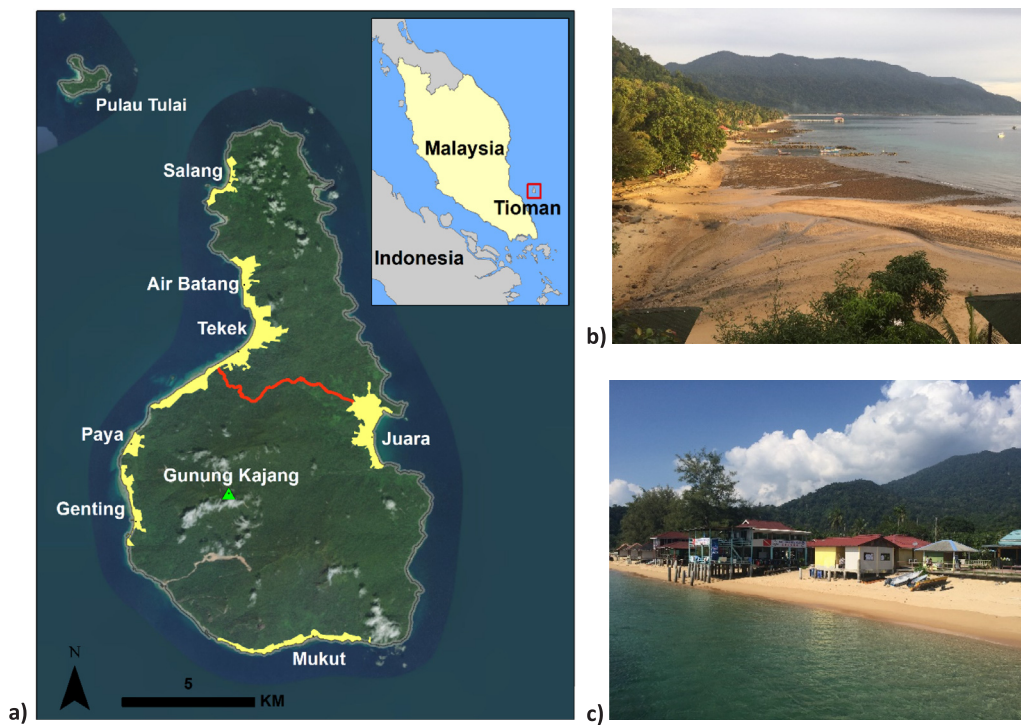


Fig. 1. a) Location of Tioman Island. It is located at 104°11'E longitude and 02°47'N latitude in the South China Sea. The yellow areas represent the official settlement boundaries (RJ Planning, 2019) of which the majority of the area is open rather than built infrastructure. The red line represents the only inland road. b) Air Batang looking south from its northern boundary. c) The village of Paya. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

managing them (Darling et al., 2019; Martín-López et al., 2017; Turner, 2000).

A variety of public participation geographic information systems (PPGIS) quantitative social survey mapping methods have been developed for assessing the potential for development conflict (Brown & Hausner, 2017; Garcia, Benages-Albert, & Vall-Casas, 2018; Kobryn, Brown, Munro, & Moore, 2018; Munro, Pearce, Brown, Kobryn, & Moore, 2017). Brown and Donovan (2013) identified conflict potential by using an index combining mapped preferences (areas of acceptable and unacceptable development perceived by residents) and place values ranging from forest gathering to commercial tourism. Raymond and Brown (2014) mapped conflict based on differences in landscape values and residential development preferences. A comparison of indices revealed that combining land use preference and the importance or intensity of place values is preferred given that it considers two dimensions of conflict – level of agreement and place importance. Other work has experimented with weighting mapped preferences, either by number of values or development (Hausner, Brown, & Lægheid, 2015; Karimi & Brown, 2017; Plieninger et al., 2018). While weighting amplify findings, they do not significantly alter the locations of mapped results (Karimi & Brown, 2017).

Alternative PPGIS mapping methods have also been developed to assess the potential for development conflict. Moore et al. (2017) conducted qualitative interviews with participants and asked them to draw polygons representing values like scenery, biodiversity, recreation, and commercial fishing. Values were re-assigned into consumptive and non-consumptive value categories. Areas of high conflict were identified in those locations containing high numbers of consumptive and non-consumptive values (Moore, Brown, Kobryn, & Strickland-Munro, 2017). Conflict has also been spatially assessed by identifying multiple visitor activities in concurrent-use locations and then compared against actual conflict locations (Wolf, Brown, & Wohlfart, 2018).

Despite the diversity in conflict assessment mapping methods, all approaches generate conflict scores that are interpreted as a binary 'support or opposition' for development, focusing on either the direction or magnitude of conflict at specific places within a region (Brown & Raymond, 2014; Moore et al., 2017; Plieninger et al., 2018). Such binary approaches discount within-community differences in attitudes

toward tourism development (Afonso et al., 2019; Bennett & Dearden, 2014; Fernandes, Guiomar, & Gil, 2015; Gorris, 2019; Troumbis & Hatziantoniou, 2018) or competing values within or between cultural groups, in regards to recreation, nature conservation and economic development (Evans, Kirkpatrick, & Bridle, 2018; Mäkitie & Ylisirniö, 2013; Wang & Yotsumoto, 2019).

A critical knowledge gap concerns how to integrate general and place-specific measures of attitudes toward tourism development with the goal of identifying potential for conflict within and across groups. The creation of novel methods for understanding the interface between these conflicts is essential to rethinking and addressing conflict as a multi-scale process of enquiry, and for managing issues of sustainable tourism and conservation in small island communities. By combining general and place specific measures of conflict, we can advance theory by showing not only which communities are concerned by different types of development proposals, but also spatially assess where conflict exists. Such methods will enable the tailoring of tourism development and conflict resolution strategies to specific areas of local concern and build on existing applications of PPGIS mapping conflict between tourism development and the environment (e.g. Brown & Weber, 2013; Fagerholm & Käyhkö, 2009; Muñoz, Hausner, Brown, Runge, & Fauchald, 2019; Plieninger et al., 2018; Raymond & Brown, 2007; Strickland-Munro, Kobryn, Brown, & Moore, 2016; Wolf et al., 2018).

The aim of this study is to present a method for surfacing the nuances in potential tourism development conflict by understanding the interrelationships between broad attitudes toward tourism development and place-specific attitudes within and between groups. We apply these methods to elicit spatial patterns of development preferences for different segments of the population of Tioman Island, located off the East coast of Peninsular Malaysia (Fig. 1). We derive new metrics for computing the directionality of preference for tourism development and conflict potential based on segmentation of our data. The methods are globally significant because they represent the first time that nuances in conflict have been articulated across different levels of attitude toward tourism development by comparing between different segments of the community.

2. Methods

2.1. Case study description

We chose Tioman Island, Malaysia as a case study because the spatial planning challenges outlined in the introduction are especially prevalent for small islands communities, who are more vulnerable to social-economic and environmental changes due to a scarcity of resources, fragile natural environments, and small domestic markets (Fernandes & Pinho, 2017; Hernández-Delgado, 2015; Ratter, 2018). Moreover, the diversity in ethnicities and cultures in Malaysia, as well as gender, presents additional challenges for equal representation of various stakeholders in planning and decision-making (Abas & Hanafiah, 2014; Ho, Chia, Ng, & Ramachandran, 2013).

Tioman Island is 19 km in length and 11 km wide and has 25,115 ha of sea area. There are seven villages scattered around the island's coastline: Kampung Genting, Kampung Air Batang, Kampung Juara, Kampung Paya, Kampung Salang, Kampung Tekek and Kampung Mukut (Fig. 1). Most villages are located on the western side of Tioman, sheltered from the northeasterly monsoon winds that blow from November until March. One main road crosses the island from east to west, connecting the main village of Tekek with Juara, while the other villages are serviced by boat (Fig. 1). To the north-west lies the uninhabited Pulau Tulai (or Tulai Island) favoured for diving, and Gunung Kajang (or Mount Kajang) is the highest point at 1,030 m from sea level and is located in the rainforest in the centre of the island, and is only accessible with an experienced guide (Fig. 1).

Since the island was gazetted as a marine park in 1998 there has been a major shift from fisheries to tourism as the main source of income for the local population of approximately 3314 people (as of 2015) (RJ Planning, 2019). Around 56% of the population reside in the main village of Tekek and are Malaysians of Malay ethnicity (predominantly Muslim) who make up 92.8% of the permanent residents, followed by Chinese Malaysians with 2.2%, according to a 2010 census, which did not include foreigner workers who commonly work in the tourism industry such as dive shops. A recent survey of 413 people on the island found the highest level of education was secondary school for 59% of the population followed by 19.9% and 15.5% for primary school and higher education respectively.

The number of tourist resorts has increased rapidly, especially between 2001 and 2008 (Omar, Othman, Mohamed, & Bahauddin, 2015). Currently there are 104 resorts and 38 dive shops on the island (RJ Planning, 2019), with 76.4% of jobs in the tourism sector. All the resorts are owned by Malaysians of Malay ethnicity, and the majority of the resorts are family ran ventures owned by locals (Reef Check, 2020). There are also 101 eateries and 58 retail/handcraft outlets which serve tourists and locals. A 2017 survey reported that the majority of the tourists are Malaysian (192,745) compared to international tourists (70,546), of which the largest segment comes from Europe, America and Oceania (30,335) and tended to be backpackers (RJ Planning, 2019).

The reefs surrounding Tioman Island are some of the most diverse and healthiest (live coral cover 62.6%) coral reefs in Malaysia (Reef Check, 2018). The Marine Park status means that fishing or collection of any marine life (dead or alive) is prohibited for a two-nautical mile radius around the island. On land, 8296 ha (61%) of the island is gazetted as wildlife reserve and the island hosts a number of endangered and endemic species including sea turtles, dolphins, mouse deer, flying foxes and vipers (Abdu, 1999).

The rapid tourism development on Tioman Island is perceived by the local community as a double-edged sword because it brings economic benefits, while unplanned or ill-designed tourism could lead to severe environmental degradation and inequality (Hanafiah, Jamaluddin, & Zulkifly, 2013; Rahman, Noor, Saad, & Yunus, 2016). In Southeast Asia, numerous islands are undergoing similar transitions to the Tioman Island, with economic activities changing from traditional

fishing to tourism (including eco-tourism). The island is currently at a crossroads with larger hotels being developed replacing existing smaller traditional guesthouse bungalows run by locals. These larger hotels are putting pressure on the environment in terms of waste services, water supply and impacts of the surrounding marine park due to increased tourist numbers. In 2018, 276,456 tourists visited Tioman and this number is expected to grow to 555,986 by 2030.

2.2. PPGIS survey and sampling

Between May and October 2018, we administered a public participation GIS (PPGIS) survey to Tioman Island residents using quota sampling. This sampling involved in-situ selection of long-term and short-term residents in major towns/villages in proportion to the Tioman Island population. A total of 317 individuals out of an estimated total population of 3300 participated in the study. The survey was available in Malay and English.

The PPGIS survey comprised of three main parts: (1) a survey of people's attitudes toward tourism development and nature conservation on Tioman Island, (2) a mapping exercise to elicit their place-based preferences for future tourism development on Tioman Island, using coloured sticker dots (referred to as "points" in the text) and an A1 hard copy colour map (scale = 1:30500) (Appendix 1) of the island and the key surrounding marine and coastal areas, and (3) respondent socio-demographics survey, including gender, age, ethnicity, kampung (village), education, job status, monthly income, and the duration and permanency of residence on the island.

We elicited broad attitudes toward tourism development aspatially using 17 statements on a five-point scale ranging from 'strongly agree' to 'strongly disagree' (part 1 of the survey). These 17 survey items were developed in consultation with the non-governmental organisation Reef Check, and reflect tourism-related environmental impacts on Tioman Island (e.g. water quality or biodiversity value), support for (or opposition to) tourism development (e.g. new tourism resorts or other facilities), and alternative trade-offs between nature conservation and tourism development. In addition, our survey items were informed by the existing literature and planning documents which have highlighted these issues previously (Abas & Hanafiah, 2014; Ho et al., 2013; Ng, Chia, Ho, & Ramachandran, 2017; Omar et al., 2015; RJ Planning, 2019), but not through the spatial and participatory planning lens.

The mapping component of the survey (part 2 of the survey) asked participants to identify their preferences for tourism development using 5 mm sticker dots containing a pneumatic code. Tourism development preferences involved residents identifying where resort development and services development could occur with a good plan, and where it should be off limits. For each mapping category, ten sticker dots were available, resulting in a maximum of 40 sticker dots per respondents. Survey participants were allowed to stick as few or as many dots anywhere on the A1 map as they wished (Supplementary Fig. 1). The large size of the map allowed respondents to identify specific villages and sections of the village as well as geographic features such as mountains peaks.

The survey responses (part 1 and 3) and the points mapped (part 2) by the respondents were digitally transcribed for further analysis using SPSS version 24 and ArcMap 10.6 (ESRI, 2019a) respectively.

2.3. Clustering respondents into groups with similar perceptions

Building on Soini and colleagues (Soini, Vaarala, & Pouta, 2012), we conducted a principal component analysis (PCA) to group the survey items on tourism development and potential impacts of tourism, and subsequently used the PCA findings to inform the clustering of respondents into groups with similar perceptions. A PCA was conducted on 17 items with an oblique rotation method (oblimin) to allow for correlation between the resulting components. For each component, we calculated the factor scores using the Regression method. The reliability

of all components was checked using Cronbach's α (a measure of (sub) scale consistency running between 0 and 1), where $\alpha \geq 0.6$ were regarded as sufficient. We then selected the components with sufficient reliability scores as an input into a K-means cluster analysis in order to group respondents. We assessed the mean differences in factor scores and individual survey items between the two cluster groups using independent samples t-tests. To compare the proportional differences in socio-demographics by cluster group we used Chi-square tests.

2.4. Spatial analysis

We applied a multi-step approach to the spatial analysis of support and opposition, and conflict and compatibility to tourism development (hereafter 'development') between the cluster groups using Kernel Density Estimation (KDE) to create point density surfaces. KDE is commonly used with PPGIS point data to identify hotspots of development preferences and landscape values (Brown & Raymond, 2014; Brown & Weber, 2012).

KDE require two parameters, the grid size and the search radius, which were calculated for four sets of point data for each type of development type (i.e. services and resort development) and development preference (i.e. support vs opposition). The search radius was calculated using an adaption of Silverman's rule-of-thumb bandwidth estimation formula (see (ESRI, 2019b)) for more information). While the grid size was calculated using the following Eq. (1):

$$p \leq \frac{\bar{h}_{ij}}{2} \quad (1)$$

where \bar{h}_{ij} is the mean nearest neighbour distance between point pairs (Hengl, 2006). The average values for the grid size and search radius were then used to derive KDE surfaces for all analyses to allow for cross comparison between PPGIS point types using a consistent parameterisation. The grid size used was 100 m and the search radius was 1839 m (Supplementary Table 1).

Step 1: Directionality of preference for tourism development

Based on the KDE parameterisation described above we generated density surfaces representing support for and opposition to development. We assessed the directionality of preference for development (i.e. supporting vs. opposing) by aggregating PPGIS points for supporting development (i.e. "Services Development" and "Resort Development") and opposing development ("Services Development Off Limits" and "Resort Development Off Limits"). Building on Brown and Raymond (2014), we then combined and rescaled the supporting and opposing surfaces to map the relative direction of support and opposition to development where pixel values were calculated using Eq. (2):

$$\text{Relative preference for development} = \frac{\text{Support} - \text{Opposition}}{\max(|\text{Support}, \text{Opposition}|)} \quad (2)$$

where "Support" and "Opposition" are the pixel values based on the density of PPGIS points calculated in each grid cell derived with KDE. The preference for development values were rescaled so that values ranging from 0 to 1 indicate the strength of support for development, while negative values ranging from 0 to -1 denote opposition to development. The values were rescaled based on the maximum recorded pixel value; either supporting or opposing development. We further calculated the difference between the two clusters (based on their "relative preference for development" maps). Finally, we aggregated all the spatial data regardless of cluster membership and calculated the relative preference for development again. This final assessment provides an estimate of overall preference for development regardless of a respondents' cluster membership.

Step 2: Intensity of conflict relating to tourism development

We repeated the same processing steps as above, except this time we used the following Eq. (3):

$$\text{Relative Conflict for development} = \frac{\min(\text{Support}, \text{Opposition}) \times 2}{\max(|\text{Support}, \text{Opposition}|)} \quad (3)$$

The Relative Conflict development analysis required rescaling to the maximum absolute pixel value (i.e. regardless of sign) calculated from the difference between support and opposition. The rescaling value is the same as used for the "Relative preference for development" thus we can compare the two outputs from Eqs. (2) and (3) in absolute terms. For example, if a pixel has a Relative conflict for development value of 0.25 and Relative preference for development of 0.5, the Relative preference for development is twice as high as the conflict. Both Eqs. (2) and (3) are complementary as Relative preference for development characterises the directionality, however, low values do not necessarily indicate a lack of support or opposition as they may cancel each other out. For example, if values for development support and opposition are both similarly high then Relative preference for development will be low and Relative conflict potential will be high.

Step 3: Directionality and conflict at key locations

For key locations across Tioman which emerged from the analysis as hotspots of points, we summarised their support for development and relative conflict for development based on the maximum values which were recorded in an area represented by a geographic feature; either a settlement, or Pulau Tulai or Gunung Kajang. We summarised development preferences by the maximum value rather than an average value, as these features varied in size (i.e. the village of Tekek is 5.6 times larger than Salang) and most respondents only included a single dot for their development preference for each location, thus larger areas would on average have smaller overall values. For Gunung Kajang a 500 m buffer was created around the peak to identify corresponding points, while for Pulau Tulai the coastline was used as the boundary. Finally, at each of these locations we calculated the difference between Relative conflict and the magnitude of Support, which represents the amount of support regardless of whether it was positive or negative. These values describe whether there is more support or conflict within a certain location. Areas with high values are where support and opposition are equally high. Areas with positive values have more conflict than support or opposition and negative values indicate the converse.

3. Results

3.1. Sample characteristics

The study participants ($n = 317$) were inhabitants of seven villages on the island: Kampung Tekek (38.5%), Kampung Air Batang (19.9%), Kampung Juara (11.0%), Kampung Paya (10.7%), Kampung Salang (10.7%), Kampung Genting (7.6%) and Kampung Mukut (1.6%). We interviewed slightly more men than women (191 and 121 respectively; this information was missing for five respondents) and they were between 23 and 79 years old. Most participants were Malay ($n = 167$), with other ethnicities including Chinese, European, Indian or other. Only 3.2% of the respondents had no formal education; these were the older respondents who were more than 40 years old. 19.6% of the respondents had at least a primary education but never completed high school and 75.4% of the respondents completed their secondary exams or higher levels of education. The majority of the respondents (53.6%) have a monthly income between RM1,000 to RM3,000, 19.3% earned less than RM1,000 and 9.2% having no income (Supplementary Table 2).

3.2. Identification of clusters from survey responses

Four components emerged from the PCA and in combination explained 51.7% of the variance in attitudes toward tourism (Supplementary Table 3). These four components represented the following perspectives (which we named): (1) opposing tourism

Table 1
Mean differences in factor scores by component and cluster group.

Component	Cluster 1 Mean (SD)	Cluster 2 Mean (SD)	t	p-value
Opposing tourism development	0.62 (0.84)	−0.72 (0.61)	16.09	p < 0.001
Supporting restrictions on boating/fishing and environmental concerns	0.53 (0.80)	−0.62 (0.83)	12.58	p < 0.001
Number of respondents in cluster	171/54%	146/46%		

development, (2) living conditions and basic needs, (3) integrated tourism and conservation strategies, and (4) restrictions on boating/fishing and environmental concerns. Two components with sufficient reliability scores, i.e. ‘opposing tourism development’ and ‘restrictions on boating/fishing and environmental concerns’ ($\alpha \geq 0.658$) were used as input for a K-means cluster analysis. The cluster analysis divided the respondents into two groups, with different perspectives on tourism development and restrictions, i.e. an ‘orientation towards limiting tourism to protect nature’ (hereafter Cluster 1) and an ‘orientation towards supporting tourism development’ (hereafter Cluster 2). The mean differences in factor scores by component showed both factors were statistically different between each cluster (Table 1).

A comparison of the socio-demographic data responses (Supplementary Table 2) and survey items responses (Table 2) between clusters revealed significant trends. Cluster 1 included 171 residents (54%) who agreed that restrictions on tourism development are needed to protect the natural environment. This group (strongly) opposed development of new tourism resorts and residential areas, supported restrictions for boating/fishing, but at the same time moderately supported new roads and services development. Members of this group were relatively young (average of 33 years) with an above average income (81% earns more than RM1000) and education level, and included relatively many public sector professionals. Smaller households were overrepresented and the average residence time was 15.5 years. 79% was Malay with the majority of respondents of European and Asian origin being part of this group.

Cluster 2 consisted of 146 respondents (46%) who strongly support tourism, infrastructure and services development while only moderately supporting boating and fishing restrictions. Most people in this group were 46 years or older and have been residing in Tioman Island for at least 25 years. Almost all (92%) were Malay and their income and

education level were lower than those in the other (‘limiting tourism to protect nature’) group.

3.3. Place-specific tourism development preferences by cluster

Development preferences were mapped 3,383 times by 317 respondents, with about equal numbers for services development and resort development (Table 3). Respondents mapped twice as many places in favour of tourism service development when compared with opposing service development. Conversely, twice as many points opposing resort development were mapped compared with support for resort development. When comparing all tourism preferences (both service and resort development) between the two clusters of respondents, we found a similar amount of supporting and opposing development points for Cluster 1. While Cluster 2 had double the number of supporting points when compared to opposing points (Table 3). Indeed, Cluster 2 assigned significantly more supporting tourism development points ($t = -4.26$) and significantly fewer opposing tourism development points ($t = 2.08$) compared with cluster 1 (Table 3).

3.4. Directionality of preference for tourism development

Overall, the spatial analysis showed that preferences for development were generally located along the coastline at nearly all beachside settlements (Fig. 2). While Cluster 1 members broadly oppose new tourism development, there are specific places where they support development, such as the main village of Tekek, and Mukut in the south (Fig. 2a). Conversely, while Cluster 2 members support tourism development across the island, there are two specific places where they oppose it: Pulau Tulai and Gunung Kajang (Fig. 2b). Thus, despite their differences in support for tourism development, respondents from both

Table 2
Mean differences in scores by component items and cluster group.

Survey items	Cluster 1 Mean (SD)	Cluster 2 Mean (SD)	t	p-value
I strongly support further tourism development on Tioman Island	3.30 (1.285)	4.40 (0.700)	−9.157	P < 0.001
I strongly support the development of new tourism services (e.g., restaurants, petrol stations, grocery stores) on Tioman Island	3.61 (1.110)	4.54 (0.623)	−8.949	P < 0.001
I strongly support the construction of new roads to and from major towns on Tioman Island	3.55 (1.362)	4.59 (0.693)	−8.281	P < 0.001
I strongly oppose the development of new tourism resorts on Tioman Island	3.82 (1.080)	2.49 (1.116)	10.642	P < 0.001
The large number of boats using waters near Tioman Island greatly concern me	4.07 (0.960)	3.21 (1.083)	7.309	P < 0.001
I strongly oppose the opening of new sites for residential development on Tioman Island	3.68 (1.107)	2.47 (1.044)	9.953	P < 0.001
I believe that restrictions need to be placed on the number of boats using waters near Tioman Island	4.30 (0.835)	3.60 (1.178)	6.068	P < 0.001
I strongly support fishing restrictions to protect the reef around Tioman Island	4.25 (1.050)	3.47 (1.303)	5.858	P < 0.001
Biodiversity (the variety of native plants and animals) decline as result of tourism development is a major problem on Tioman Island	4.25 (0.884)	3.00 (1.078)	10.981	P < 0.001
<i>Living conditions and basic needs</i>				
The availability of water and electricity to support residential development is a major problem on Tioman Island	3.90 (1.031)	3.88 (1.090)		n.s.
The reduction of fresh water quality is a major problem on Tioman Island	4.02 (1.044)	3.48 (1.253)	4.154	P < 0.001
The lack of employment opportunities is a major problem on Tioman Island	3.30 (1.167)	3.70 (1.141)	−3.094	P < 0.01
<i>Supporting tourism management and conservation</i>				
I strongly support new conservation strategies to manage the spread of invasive plant species on the reef	4.52 (0.757)	4.59 (0.640)		n.s.
New strategies are needed to integrate tourism and conservation planning on Tioman Island	4.57 (0.653)	4.45 (0.735)		n.s.
<i>Other items</i>				
I strongly support increases to overseas tourism investment on Tioman Island	2.62 (1.227)	3.09 (1.315)	−3.249	P < 0.01
I strongly support strategies to protect biodiversity (the variety of native plants and animals) even if they limit employment opportunities on Tioman Island	4.08 (1.030)	3.65 (1.149)	3.467	P < 0.01
There are too many tourists in major towns on Tioman Island	3.59 (1.048)	3.75 (0.991)		n.s.

Table 3

Number, proportion and mean differences in limiting and supporting tourism development preferences by attribute.

Development preference	Cluster	N	Number points	% total	Mean	S.D.	T	p
Resort Development	1	167	267	15.4	1.56	2.22	−4.26	***
	2	145	290	16.7	2.69	2.48		
Services Development	1	167	605	34.8	3.62	2.51	−1.21	ns
	2	145	576	33.1	3.97	2.60		
		Sub-total	1,738	100.0				
Resort Development Off Limits	1	167	690	44.5	4.13	3.08	4.78	***
	2	145	377	24.3	2.60	2.56		
Services Development Off Limits	1	167	297	19.1	1.78	2.22	2.08	*
	2	145	188	12.1	1.30	1.83		
		Sub-total	1,552	100.0				

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ns = not significant.

clusters rejected development on Pulau Tulai and Mount Kajang. Fig. 2c shows the areas for which Clusters 1 and 2 have the most diverging views. While both clusters oppose tourism development on Pulau Tulai, the strength of the opposition to development in these locations are much higher in Cluster 1 than Cluster 2, resulting in the negative scores in Fig. 2c. Finally, Fig. 2d shows the level of development support or opposition regardless of cluster.

3.5. Intensity of tourism development conflict

We found many differences when comparing the intensity of tourism development conflict between the clusters. For Cluster 1 most locations on the island apart from Mukut in the south, Gunung Kajang and Pulau Tulai had high conflict (Fig. 3a). In comparison, Cluster 2 had much less conflict while showing similar spatial patterns (Fig. 3b). Interestingly, there were very little differences in conflict potential between Cluster 1 and Cluster 2 at Mukut, Gunung Kajang and Pulau Tulai (Fig. 3c). When considering all respondents as one group, most of the locations on the island show high conflict potential, especially for Tekek (Fig. 3d).

3.6. Directionality of preference and conflict comparison

In general, Cluster 1 expressed greater conflict than overall support for development while Cluster 2 generally supported development, with the exception of Tekek that had the highest relative support for tourism development (Table 4). In contrast, relative opposition for development was much less for Cluster 1 compared with Cluster 2, with the lowest value of −0.39 and −0.1, respectively for Pulau Tulai. The potential for tourism development conflict was much greater for Cluster 1, with areas such as Juara, Paya and Salang showing higher potential for conflict than relative support or opposition for development. For example, conflict at Juara was seven times as great as support for development. The comparison of conflict verses magnitude of support as indicated by low or negative values showed that conflict was at similar levels to support or less. For Cluster 2 the support for development in Tekek is very apparent with support for development twice as high as conflict.

4. Discussion

4.1. Spatial conflict analysis between groups

We present a new PPGIS analyses method for spatially assessing the potential for conflict across different levels of attitude toward tourism development within and between different segments of the population. Such an approach is needed to tailor planning of conservation and tourism development on small tropical island communities to areas of different community concern, but also can be used in other planning contexts where land use decision making is contested. Our findings build on previous PPGIS research by highlighting that the magnitude

and spatial distribution of the potential for tourism conflict varies both spatially and aspatially. Those communities who generally oppose tourism development (resorts and services) can identify specific places in a given study area that they support tourism. Conversely, those communities who generally support development can also identify specific areas that they oppose development.

Segmentation of location specific conflict potential by groups with broadly similar attitudes toward tourism provides an added layer of nuance to theory and practice regarding the assessment of tourism conflict and mapping of land use development preferences. In addition to defining between community differences in attitudes toward tourism development (Afonso et al., 2019; Bennett & Dearden, 2014; Fernandes et al., 2015; Gorris, 2019; Troumbis & Hatziantoniou, 2018), the new methods presented here enable identification of within community differences in the intensity and direction of tourism conflict in specific locations. While clustering analysis is quite common in tourism studies, it is usually an endpoint to inform marketing strategies or tourism planning (e.g. Pavlič, Portolan, & Puh, 2019). Segmentation has also been used to identify groups of landholders that are willing and equipped to participate in land conservation incentives programmes, using information on socio-demographics, human capital, trust and social connectedness (Morrison, Duncan, & Parton, 2013; Morrison, Durante, Greig, Ward, & Oczkowski, 2012). Our study showed that non-spatial differences in attitudes characterised by the cluster analysis manifest themselves as large differences in place-based preferences.

We also extend PPGIS theory and methods by adding further nuance to spatial indicators of potential for development conflict. Rather than win-loss arguments, we are able to recognise that all residents, irrespective of their general attitudes toward tourism, can have areas where they support or oppose tourism. This opens up the negotiation space for conservation and development strategies to be tailored to specific areas in ways that could not have been achieved in previous participatory mapping applications (Brown & Raymond, 2014; Plieninger et al., 2018; Moore et al., 2017; Brown, Strickland-Munro, Kobryn, & Moore, 2017). From a conflict resolution perspective, these methods are significant given they suggest space for engaging with residents who generally oppose or seek to limit tourism development. Despite general opposition to tourism in Cluster 1 ('limiting tourism to protect nature' group), residents in this cluster could also identify place-specific areas that are acceptable to tourism development, subject to a sound plan (Fig. 2a, 3a), which are not revealed in common approaches to conflict assessment (Fig. 2d and 3d). Conversely, residents who expressed general support for tourism development (Cluster 2; "supporting tourism development") could also identify place-specific areas like Pulau Tulai where they opposed it. Faced with extreme pressures to develop, coastal managers could engage with Cluster 1 residents in specific areas about opportunities for new development activities.

Our methods also reveal the overall directionality of conflict. Previous work has identified where conflict exists (Brown & Raymond, 2014; Moore et al., 2017; Plieninger et al., 2018), but not identified whether it is oriented towards supporting or opposing development. For

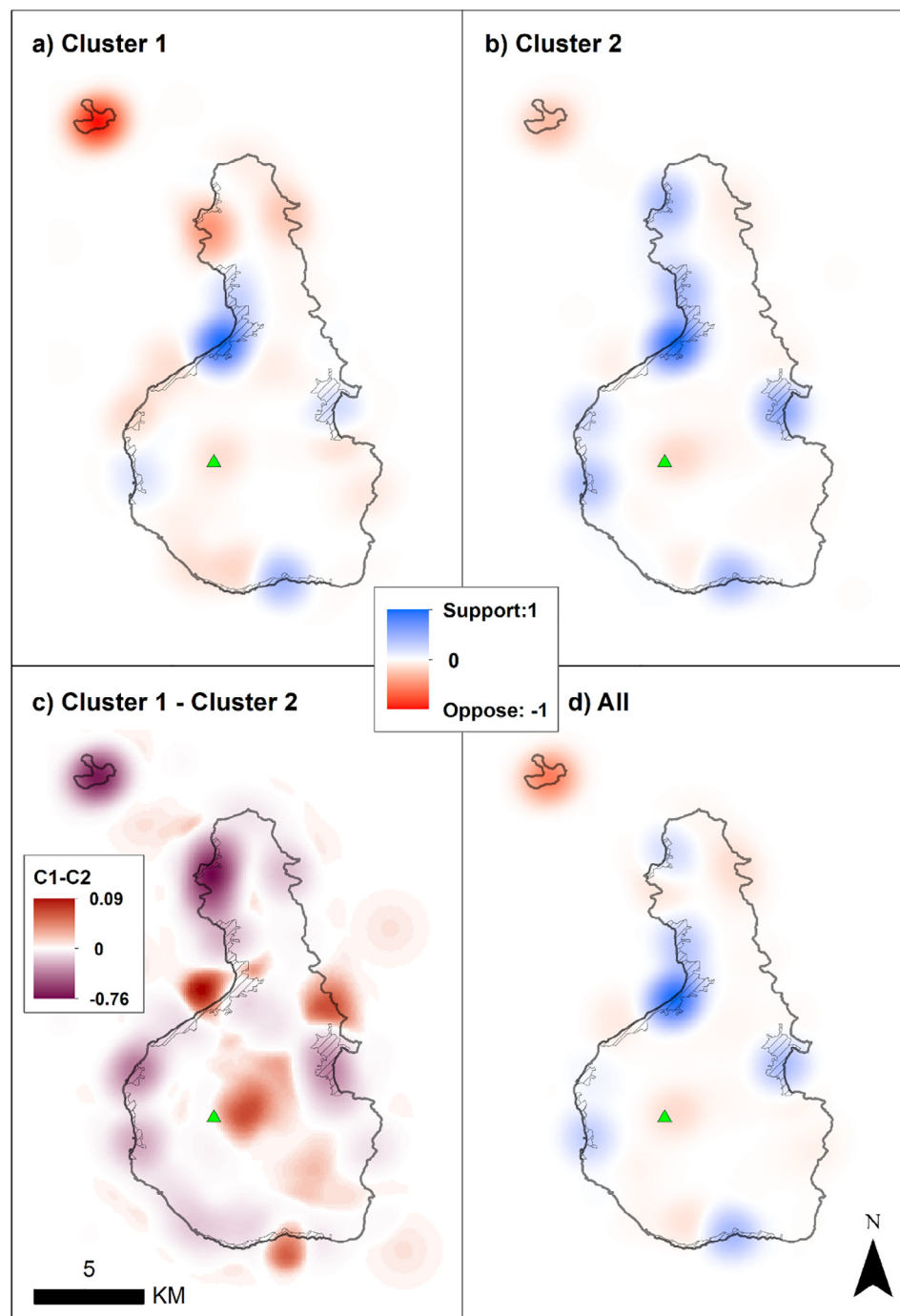


Fig. 2. Relative preference for tourism development. Maps depicting the relative level of preference for tourism development for Cluster 1 (a) and Cluster 2 (b), the difference between maps a and b (c), and without clustering (d; all data). Note for (c) the colour scale is equal for both positive and negative values even though their magnitude is different.

all clusters, conflict was oriented towards supporting development, with the exception of areas in the north of Tioman Island. However, in general there was more conflict than support or opposition for development at any single location with major differences between the two clusters (Table 2).

Our approach to the assessment of the potential for development conflict addressed the “where” question of sustainable tourism, but did not consider important questions around whether residents “want tourism” and the impacts of tourism on quality of life, livelihoods and culture (Andereck et al., 2005; Choi & Sirakaya, 2005; Hsu, Chen, Nyaupane, & Lin, 2020; McGehee & Andereck, 2004). While our

questionnaire items were driven by well-known and important local issues (Abas & Hanafiah, 2014; Ho et al., 2013; Ng et al., 2017; Omar et al., 2015; RJ Planning, 2019), future research could adapt theories and practices from outside of the spatial and participatory planning literature, especially through utilising existing scales such as Resident Empowerment through Tourism Scale (RETS) (Boley & McGehee, 2014) or Sustainable Tourism Attitude Scale (SUS-TAS) (Choi & Sirakaya, 2005). For example, research on residents attitudes using non-spatial questionnaires for specific conflict locations could be an interesting way to understand the broader drivers of the patterns of spatial conflict from the perspective of socio-cultural impacts to long-term planning

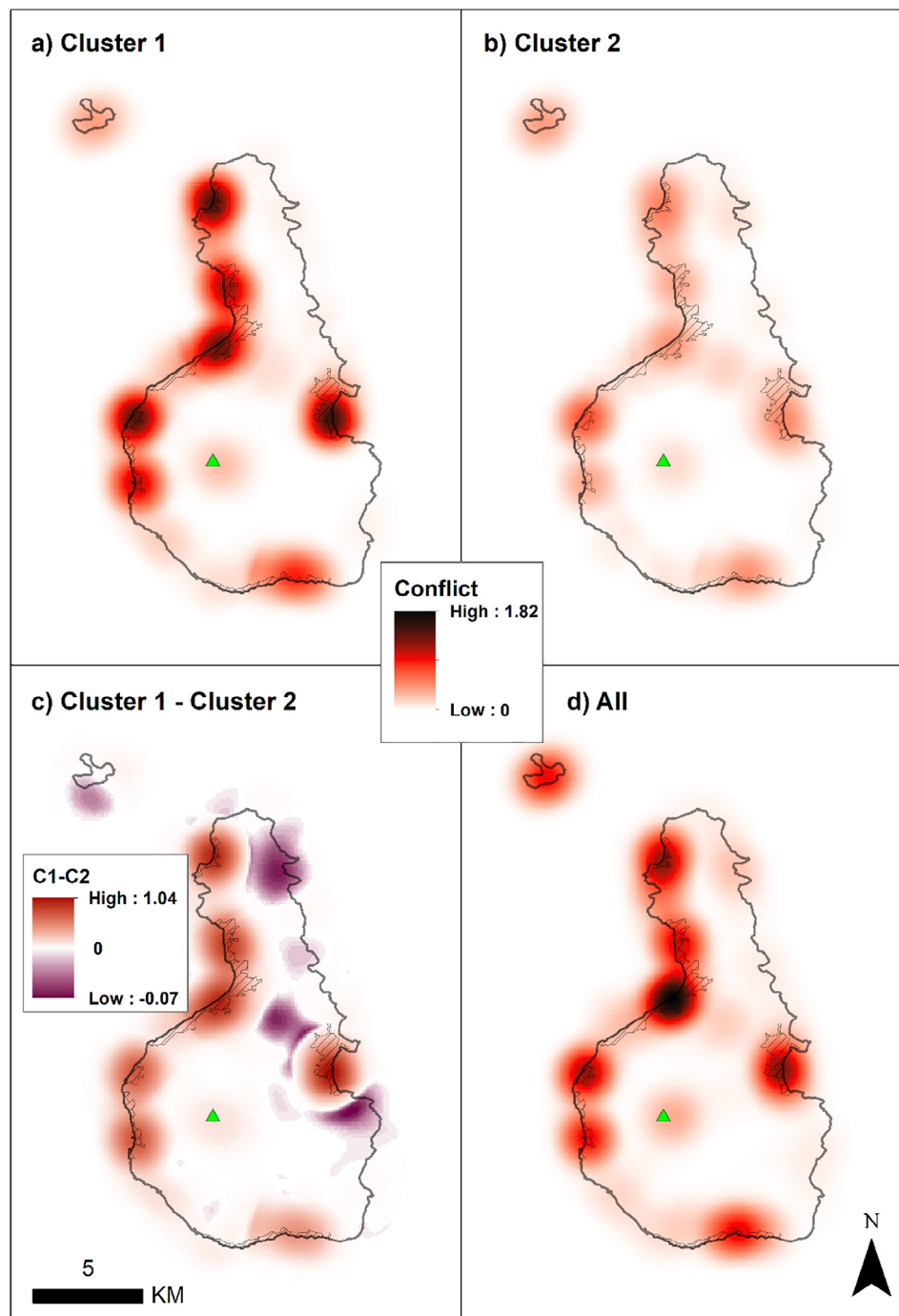


Fig. 3. Relative conflict for tourism development. Maps depicting the intensity of conflict for Cluster 1 (a) and Cluster 2 (b), the difference between maps a and b (c), and without clustering (d; all data). These values have been calculated as the number of points supporting and opposing development, where 0 equals no conflict (compatibility) and 1 equals maximum conflict. Thus, only map c has negative values. Note, the values have been rescaled using the same method as in Fig. 2 to allow for comparison. Most conflict potential values are relatively higher than the values in Fig. 2, hence the values are greater than 1.

(Andereck et al., 2005; Choi & Sirakaya, 2005; Hsu et al., 2020) and/or consider tourism from the perspective of social exchange theory, which has often been used as a framework to view residents attitudes (Andereck & Nyaupane, 2011; McGehee & Andereck, 2004).

The general limitations associated with the application of PPGIS and social data to support conservation planning have been reviewed elsewhere (e.g. Brown, Reed, & Raymond, 2020; Lechner et al., 2014). However, there are a few study specific limitations that need to be addressed. Our mapping results represent the variable and complex nature of human-place relationships (Brown et al., 2020) as well as the

ability of different respondents to interact and engage with the mapping process. For example, respondents varied dramatically in their experience of the Tioman Island, with divers on one hand regularly travelling to multiple locations across the islands, while hospitality staff at small family restaurants may rarely leave their village. Future research can try and capture these differences in world view providing a greater understanding of the linkages between landscapes, assigned values and ultimately human well-being (Fagerholm et al., 2020) which can then be linked to conflict over development.

Table 4

Maximum pixel value for Relative support for tourism development¹, Relative conflict for tourism development², and Conflict versus magnitude of Support³ (i.e. amount of support regardless of whether it was positive or negative) calculated for specific geographic locations on Tioman and their area in hectares.

Location	Pixels	Area (Ha)	Relative Preference for tourism development				Relative Conflict for tourism development				Conflict vs Magnitude of Support		
			Cluster 1	Cluster 2	C1 - C2	All	Cluster 1	Cluster 2	C1 - C2	All	Cluster 1	Cluster 2	All
Air Batang	85	85	0.34	0.42	-0.05	0.37	1.19	0.36	0.85	1.05	0.85	-0.07	0.80
Genting	67	65	0.17	0.40	-0.07	0.31	1.09	0.42	0.73	0.97	0.92	0.02	0.66
Gunang Kajang	74	78	-0.09	-0.08	0.03	-0.09	0.26	0.15	0.12	0.34	0.17	0.06	0.09
Juara	193	194	0.22	0.55	0.00	0.41	1.53	0.49	1.04	1.29	1.31	-0.06	1.03
Mukut	112	106	0.46	0.43	0.04	0.44	0.87	0.44	0.43	1.01	0.42	0.01	0.40
Paya	40	39	-0.11	0.23	-0.30	0.07	1.43	0.72	0.71	1.22	1.32	0.49	0.41
Pulau Tulai	126	123	-0.39	-0.10	-0.29	-0.22	0.39	0.40	0.03	0.97	0.00	0.29	-0.25
Salang	48	49	0.00	0.44	-0.28	0.21	1.46	0.53	0.94	1.26	1.46	0.09	0.66
Tekek	271	274	1.00	1.00	0.05	1.00	1.37	0.44	0.95	1.82	0.37	-0.56	0.90

¹ Relative support for tourism development – blue cells indicate support for development and red indicate opposition to development.

² Relative conflict for tourism development – low conflict locations are represented by blue cells and high conflict with red cells.

³ Conflict versus Magnitude of Support – blue cells represent greater magnitude of support than conflict while the red cells represent the opposite.

4.2. Spatial conflict and island tourism development

In the context of Southeast Asia, Tioman Island represents the typical challenges associated with development on islands where income primarily comes from tourism and future income opportunities are tied to increased development, which in turn may impact on the integrity of the natural coastal and coral ecosystems which drew tourists to the island in the first place (Domroes, 2001; Jobbins, 2006; Kurniawan et al., 2019; Moghal & Connell, 2018; Robinson, Newman, & Stead, 2019). Of the respondents surveyed 29.6% reported incomes below 1000 RM per month (the equivalent of 239 USD or 214 Euros as of 22/10/2019) which is the minimum wage in Peninsular Malaysia. In this context, it is understandable that residents seek out new livelihood, employment and thus development options. However, all respondents regardless of cluster membership supported strategies to integrate tourism and conservation planning. In fact, the highest level of agreement and the lowest standard deviation in the questionnaire was in response to the two survey items that referred to “Supporting tourism management and conservation” (Table 2). Furthermore, respondents showed much higher support for services development than resort development.

For Tioman Island and other small island communities across Southeast Asia there are important questions concerning the type and intensity of future development. Much of the existing environmental research on sustainability of small tropical island communities have focused primarily on the relationship between livelihoods and surrounding marine environment and/or marine protected areas (e.g. Bennett & Dearden, 2014; Bonerate, 2018; Dunning, 2018; Masud, Aldakhil, Nassani, & Azam, 2017). However, land-use decisions concerning resort and services development are likely to have cascading environmental impacts. According to Shida Irwana et al.'s (2013) assessment of Tioman Island based on Butler's tourist area cycle of evolution model (Butler, 1980), the island is at the consolidation stage and moving forward there are a number of potential futures. One of these futures could be increasing development and numbers of tourists leading to the degradation of the natural qualities of the island and therefore the tourism product. In turn this may lead to cost-cutting and undervaluation and further degradation of coral reef resources (Jobbins, 2006). Such a development trajectory often involves mass market all-inclusive resort and high volume tourism which is commonly associated with environmental impacts (Jobbins, 2006). Since this

survey was completed, a recent plan outlined the government's vision for the island which will include building sewage treatment centre, rain harvesting centres and waste recycling centres to deal with the increasing number of tourist (RJ Planning 2019). In addition, even more recently, the national government is proposing the development of an international airport (ASPEC, 2020), which will radically alter Tioman Island's environment and society.

Participatory planning approaches enable the values and preferences of residents to be systematically integrated into tourism development zoning. The conflict maps generated through this study also provide a voice to organisations representing local residents who seek to spotlight issues beyond the Malaysian government's current focus on economic development and foreign investment. In fact, the third phase of the Tioman development plan (RJ Planning 2019) roadmap commissioned by Plan Malaysia includes community engagement. Such an engagement approach may be well suited to Tioman; due to its status as a Malay reserve, the majority of the resorts are owned by Malaysians (Reef Check, 2020), who have lived on the island for many generations and/or small business owners and employees who are personally invested in Tioman Island, but are rarely consulted in a systematic way.

5. Conclusion

Our spatial analysis provides cautious support for development (especially services development), in particular areas (i.e. Tekek), protection of other areas (i.e. Pulau Tulai and Gunung Kajang) and in other areas development is likely to be contentious and potentially may divide the community (i.e. Juara). Tioman Island has often been a focus for government tourism investment; though sometimes inappropriate and without consideration for potential environmental impacts. Since this survey was conducted, the government has released a report outlining a proposal for a number of new developments including the recycling of a controversial international airport development proposal which is likely to have huge impacts on the environment and surrounding coral reef (<https://www.youtube.com/watch?v=sGlqYy34i0c>). However, our analysis suggests that only development which does not impact on the natural environment (Supplementary Table 3) are likely to be supported by the community.

Small tropical island tourism will inevitably increase human impacts on both terrestrial and marine systems and potentially be magnified by climate change (Hernández-Delgado, 2015; WMO, 2010);

therefore the need to ensure development is sustainable is even greater. Limiting impacts of development requires considerable planning, good policies investment, enforcement of standards, good science and public awareness. A crucial element of the planning process and an important starting point, can be achieved through the application of PPGIS and the spatial metrics proposed in this paper, providing a voice for different segments of the community and transparency around attitudes, values and preferences for development. The novel methods outlined in our paper allows for the nuances in conflict to be articulated spatially across different levels of attitude toward tourism development within and between different segments of the population. Our results suggest that treating a population as homogeneous risks missing place specific development conflicts between segments of the population and locations of agreement where development can be managed sustainably with the support of the community.

Author contributions

The manuscript was conceptualized and written by AML, LNHV and CMR. AML, LNHV, CMR and MLEA contributed to the data analysis. AML, LNHV, CMR and AC contributed to data collection. All authors contributed to the editing and reviewing the paper.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.landurbplan.2020.103902>.

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